

EVERGREEN[®]

THE MODERN DATA STORAGE PARADIGM

Data storage technology changes fast. At the enterprise level, it seems that every three to five years, developments in technology make enterprise storage systems either technically obsolete or uneconomical to operate.

Enterprises cope with this by periodically *refreshing* (replacing) their storage equipment in “forklift upgrades” that effectively require them to repurchase storage capacity they already own.

Refreshing storage systems is costly and disruptive. Planning, budgeting, procuring, installing, testing, migrating data, and integrating the new storage systems into IT operations is a months-long series of labor-intensive, risky projects that divert IT teams from an enterprise’s core mission. It’s not uncommon for enterprises with hundreds of storage systems to constantly have several storage refresh projects underway, consuming resources, disrupting business, and risking permanent data loss.

What if it didn’t have to be that way?

- ▶ What if storage system lifetimes were decade or more during which the systems *improved* rather than becoming obsolete?
- ▶ What if storage could meet enterprises’ changing needs without disrupting applications?
- ▶ What if data never had to migrate?

That’s what Evergreen[®] does!

This brief describes Pure Storage’s *Evergreen* subscription concept. With Evergreen, storage stays responsive to user needs while eliminating the cycles of cost and disruption that have historically been a fact of IT life.

EVERGREEN CHANGES THE ENTERPRISE STORAGE MODEL

Evergreen improves the enterprise storage ownership experience in four fundamental ways:

Risk Reduction

- ▶ No risk of data migrations going wrong.
- ▶ No disruption due to hardware or software upgrades.
- ▶ No risk of buying capacity for needs that never materialize.
- ▶ No risk of hobbling applications by buying insufficient performance.

Financial Flexibility

- ▶ Decade+ system lifetimes with predictable subscription fees eliminate planning and budgeting for periodic “forklift upgrades.”
- ▶ High density storage and long system lifetimes minimize e-waste.

IT Agility

- ▶ Pure1 monitoring and analytics facilitate workload balancing and enable accurate capacity planning.
- ▶ Non-disruptive capacity and/or performance upgrades are available whenever and however required.

Operational Efficiency

- ▶ Uninterrupted client access to data throughout a system’s life.
- ▶ Administrative simplicity and consistent user interfaces free DevOps resources for activities with more direct value to the enterprise.

THE EVERGREEN CONCEPT

Evergreen is a program of subscription services for Pure Storage systems. The name is a metaphor that captures the program's essence. With Evergreen subscriptions, the company's products are literally *ever green*; unlike conventional storage systems, they don't become obsolete or uneconomical to operate or need to be replaced every few years.

Evergreen eliminates storage refresh cycles, as evidenced by the fact that nearly all Pure Storage systems ever shipped are still in service. Many contain none of their original hardware or software, but today they are more reliable, perform better, use less space and power, and have larger capacities and capabilities that didn't exist when they were installed. And they're ready for the next decade of technological evolution. Moreover, the hardware and software upgrades that have modernized them have been and will continue to be *non-disruptive*—performed while the systems are in use with no downtime or performance degradation.

The Purity software that drives Pure's systems is what makes Evergreen possible. A fundamental property of Purity is *non-disruptive upgrade* (NDU)—the software enables both software and hardware to be upgraded while systems are operating. NDU encourages users to keep their storage both technologically current and responsive to their changing needs. Enterprises aren't saddled with systems that become inadequate as they age until the next refresh cycle. Freed from the need to periodically disrupt operations to refresh storage, they can devote more resources to activities that benefit their core missions directly.

An up-to-date installed base creates a virtuous cycle. Because most of Pure's products in the field are up to date, the company can devote more of its R&D resources to innovation. New products and features reach customers faster, user feedback on them encourages more innovation, and the cycle repeats. Evergreen inverts the enterprise data storage paradigm, from a **depreciation** model of static storage systems with anticipated obsolescence, periodic replacement, and the attendant data migration, to:

*an **appreciation** model of storage systems whose capabilities improve as technology evolves and as user needs change, without disrupting operations or migrating data.*

WHY TOLERATE STORAGE LIFECYCLES?

Storage technology evolves so fast that after three to five years in service, installed systems underperform newer offerings or become unreliable or too expensive to maintain. Vendors often encourage “upgrading” by increasing support costs or discontinuing support for older products.

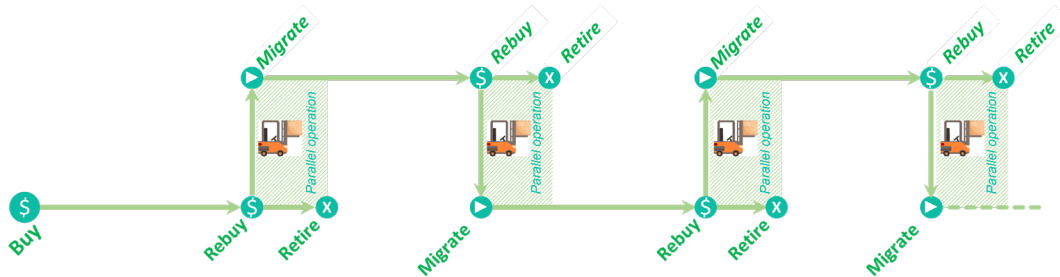


Figure 1: The Enterprise Storage Treadmill

Every storage refresh incurs cost, complicates operations, and introduces risk:

- ▶ Each entails budgeting, planning, procurement, delivery, installation, testing, parallel operation, and disposal of old equipment.
- ▶ Replacing systems, updating software licenses, migrating data, and reprovisioning take IT operations teams away from their core responsibilities, sometimes for months.
- ▶ Migrating data causes application outages that disrupt business and may result in permanent data loss if something goes wrong.

The result is more cost, greater risk, and ultimately, distraction from an enterprise’s core mission.

OTOH, EVERGREEN SUBSCRIBERS...

- ▶ Don’t have expensive and disruptive cycles of planning, budgeting, procuring, and staffing for “rebuy, rip, and replace” storage refresh cycles.
- ▶ Procure storage to meet immediate needs, knowing that they can increase capacity and/or performance at any time with no downtime or data migration.
- ▶ Count on regular software releases, some with new capabilities, and on available equipment upgrades that keep their storage systems modern.
- ▶ Predict future storage costs with subscription pricing that doesn’t increase.

With Evergreen, storage becomes a long-term investment whose value **increases** over time because it both tracks technology and meets user requirements as they evolve. Pure Storage calls this new enterprise storage paradigm the *Modern Data Experience™*.

Pure’s systems have many technical advantages—consistent high performance, high availability, low power consumption, efficient use of physical capacity, and administrative and user *simplicity*¹.

¹ Based on Pure1® data, the company estimates that administrators can manage as much as ten times more FlashArray™ or FlashBlade® capacity than is common with other vendors’ storage systems.

Pure's business practices also offer advantages (summarized in the Appendix on page 9) that are uncommon elsewhere in the industry. Evergreen further enhances the customer experience with decades-long system lifetimes of uninterrupted service during which the systems improve, with predictable long-term operating costs, and with no data migration risk.

THE EVERGREEN JOURNEY: AN EXAMPLE

Figure 2 suggests how a FlashArray system delivered in the company's early days might have evolved over ten years with Evergreen//Forever. The large ○ shapes indicate non-disruptive hardware upgrades, the smaller ones, a sampling of software updates.

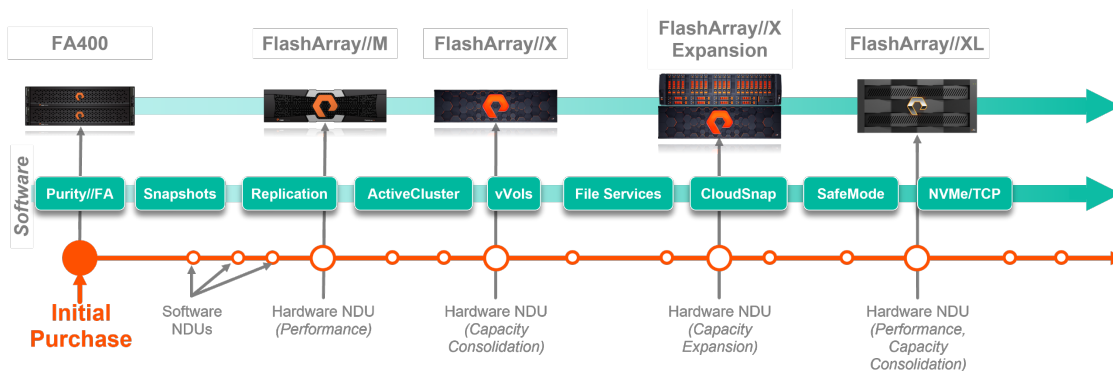


Figure 2: An Evergreen Journey

Hardware upgrades may have modernized technology, or they may have satisfied the user's need for additional capacity or I/O performance. The figure indicates modernizations from:

- ▶ The original FA400 to Pure's first in-house controller design (FlashArray//M),
- ▶ FlashArray//M to the higher-performing FlashArray//X, and from SSDs to *DirectFlash™* Modules (DFMs),
- ▶ FlashArray//X to FlashArray//XL with its 60% higher performance and higher density DFMs for a smaller data center footprint.

Over a decade of use, added software capabilities would have included:

- ▶ Automatic and on-demand snapshots and replication to remote arrays or public clouds.
- ▶ Native file services.
- ▶ Support for VMware virtual volumes (vVols).
- ▶ SafeMode protection from ransomware attacks.

and many others. These capabilities automatically became available to all Evergreen subscribers immediately upon release. All hardware and software upgrades would have been performed while the system was operating. Today, none of the system's original components would be present, but the data would have been in continuous use as the system evolved.

Evergreen completely upends the enterprise data storage paradigm.

INSIDE EVERGREEN

Evergreen subscriptions are based on the architecture that defines how Pure Storage designs products. The subscriptions deliver the resulting product benefits to Pure's customers.

THE PURE STORAGE ARCHITECTURE

Pure Storage regards data storage as advanced technology rather than a commodity that simply supports the rest of the IT stack. Throughout its history, the company has demonstrated this with innovations such as two-stage data reduction, symmetric synchronous data replication, DFMs that are demonstrably superior to mass market SSDs, and many others. These are reflected in the quality and utility of the company's products, but two are especially key enablers of Evergreen:

MASTERY OF FLASH TECHNOLOGY

Rather than SSDs, Pure Storage systems use DFMs of its own design for persistent storage. DFMs are superior to other types of solid-state storage partly because the company invests heavily in fully understanding each new generation of flash and adapts firmware and Purity software for optimal results. Pure's DFMs have greater capacity, more consistent performance, lower power consumption, and longer lifetimes than SSDs built with the same flash technology.

High DFM reliability and endurance contribute to system longevity and make Evergreen's lifetime device replacement guarantee possible.

PURITY SOFTWARE

The Purity software that drives Pure's systems enables key features that Evergreen exploits:

CROSS-GENERATIONAL NON-DISRUPTIVE UPGRADE (NDU)

All Pure Storage systems are software and hardware upgradable while operating. Evergreen NDU differs from other vendors' "non-disruptive" upgrades, which typically require data migration, are limited to a single refresh, and/or prohibit upgrading across generations.

Throughout the company's history, NDU has been a feature of its systems, even when hardware generations have differed significantly. For example:

- ▶ 2015: from FA400 to the first in-house designed FlashArray//M platform.
- ▶ 2023: FlashArray//X to FlashArray//XL with its unique chassis and NVRAM designs.²
- ▶ 2020-present: interconnect transitions from SAS, Fibre Channel, and iSCSI to NVMe.

During the past decade, Pure Storage and partner technicians have performed many thousands hardware upgrades and countless software ones. Some of the company's early

² For a detailed description of this NDU, see <https://blog.purestorage.com/purely-technical/non-disruptive-upgrade-to-flasharray-xl-2/>

systems have been modernized as much as six times. Today, many contain none of their original hardware; they have effectively become new systems while they were operating.

With cross-generational NDU, Evergreen systems can evolve with technology while continuing to meet changing user needs for a decade or more.

DETAILED SYSTEM BEHAVIOR AND EVENT TRACKING

Even in Pure's earliest systems, Purity automatically logged and reported status and events to a company repository, using a secure communication path called *phonehome*. The repository has evolved into the database that the Pure1™ cloud-based consolidated management and capacity planning system³ uses to track and analyze the company's entire installed base⁴. Detailed tracking and analysis enables:

- ▶ Automated response to issues in deployed products (over 60% of all support tickets are initiated by Pure1 before customers are aware of issues).
- ▶ "Fingerprinting" that detects known issues before they arise in other systems and initiates preventive measures.
- ▶ Centralized self-monitoring of an enterprise's entire fleet of Pure Storage products.
- ▶ AI-based workload analysis and capacity planning, including "what if" modeling.

Event logging allows Evergreen subscribers to view and actively manage their entire complement of Pure Storage products from a single console or management app.

PRODUCT LINE CONSISTENCY

Although the capabilities of Pure's systems have evolved significantly over the past decade, Purity has preserved their common "look and feel." Users and management apps interact via the same interfaces today that they used with the first systems shipped. New features and products add capabilities, but they preserve existing ones.

Consistent capabilities and interfaces across product generations minimize retraining needs and simplify NDU for IT operations teams.

To maintain and further develop these capabilities and system properties, Pure invests more heavily in R&D than is typical of its major competitors. The company's high level of R&D illustrates its on-going commitment to an engineering philosophy that treats storage as high technology and makes it possible to deliver Evergreen's one-of-a-kind benefits to customers.

³ Pure1 facilities are available to all Evergreen subscribers.

⁴ Systems only log status and events; no customer data is ever transmitted. Logs are not collected from so-called "dark sites" that do not allow external connections.

EVERGREEN SUBSCRIPTIONS

Some Pure Storage customers purchase complete storage systems; others purchase hardware at a substantial discount and pay only for the capacity they use on a subscription basis.⁵ Either purchase model is suitable for enterprises that must own the storage that holds their data assets, due either to internal policies or to regulatory requirements:

- ▶ System purchase is optimal for enterprises whose business models favor ownership of capital assets. It works best when data requirements (including growth) are predictable.
- ▶ Enterprises with limited capital budgets and/or fluctuating storage usage may prefer to purchase hardware and pay only for the capacity they use each month.

Evergreen subscriptions replace the periodic *maintenance fees* common with other vendors. They provide equivalent benefits; the way in which benefits are delivered differs somewhat based on subscription type. Table 1 lists the Evergreen subscriptions for purchased storage.

Customer Purchase	Subscription	Benefits
Storage Systems with defined capacity and capabilities	Evergreen//Foundation	For the lifetime of the system(s): • Regular updates including new software capabilities. • On-demand technology and capacity upgrade purchases.
	Evergreen//Forever	Evergreen//Foundation benefits plus: • Unlimited system lifetimes • Periodic technology refresh. • Returned equipment credit for on-demand upgrades.
Storage Capacity with defined capabilities	Evergreen//Flex	Evergreen//Forever benefits plus: • Hardware purchased at a substantial discount. Subscription charge based on capacity <i>used</i> each month (not on purchased capacity). • Flexibility to deploy purchased capacity on-premises, at a co-location site, or in a public cloud (AWS or Azure) using Cloud Block Store (CBS) virtual FlashArrays. • Option to move purchased capacity (“data packs”) among subscribed systems at an on-premises or co-location site.

Table 1: Evergreen Subscriptions for Purchased Storage

The sections that follow describe the three offerings.

⁵ Some enterprises procure their storage via the *Evergreen//One™* storage-as-a-service subscription model, discussed separately in TB-230601o, available at <https://support.purestorage.com> and from Pure Storage representatives.

EVERGREEN//FOUNDATION

Evergreen//Foundation is Pure's basic subscription offering for purchased systems. Subscribers receive periodic software updates and can purchase additional capacity and/or modernize their systems at any time. Evergreen//Foundation subscriptions may remain active until the end-of-life date of the originally purchased system.⁶ The key features of Evergreen//Foundation are:

SOFTWARE UPDATES

Pure Storage updates the software in its products every one to three months. Updates are available to all Evergreen subscribers at no incremental cost. They include performance enhancements and bug fixes for both system software and DFM firmware.

HARDWARE MODERNIZATION

Evergreen//Foundation subscribers can modernize or upgrade the technology in their storage systems by purchasing newer or more powerful components. For example, they can upgrade FlashArray controllers or FlashBlade blades to newer and/or more powerful models.

CAPACITY INCREASE AND CONSOLIDATION

Customers can increase system capacity by adding data packs of DFMs, or blades or chassis to FlashBlade systems. DFMs can be replaced by higher-capacity ones for a smaller data center "footprint" with lower power consumption.

EVERGREEN//FOREVER

Evergreen//Forever is Pure's premium subscription for purchased systems. There is no limit to system lifetimes as long as subscriptions are continuously active. Evergreen//Forever includes all features of Evergreen//Foundation, with two important additions:

REGULAR TECHNOLOGY MODERNIZATION

Continuous system modernization by periodic replacement of key components (controllers, blades, DFMs, power supplies, chassis, etc.) with the most current equivalents.⁷ Purity software updates include any newly-released features. Component replacements and software upgrades do not change subscription rates.

ON-DEMAND CAPACITY, PERFORMANCE, AND ENERGY EFFICIENCY UPGRADES

Subscribers can meet changing needs at any time by adding or consolidating capacity or by exchanging controllers or blades for more powerful ones. For example:

- ▶ FlashArray controllers can be exchanged for more powerful models.
- ▶ DFMs, blades, and/or chassis can be added to FlashBlade systems, or capacity-optimized blades can be replaced with performance-optimized ones.

⁶ Pure announces product end-of-life dates to customers who may be affected by them. Evergreen//Foundation subscriptions can no longer be renewed after end-of-life of the original configurations, even if some of a system's components have been replaced with newer ones that are not at end-of-life.

⁷ For example, at publication time the controller/blade replacement interval for FlashArray//XL, FlashArray//X, FlashArray//C, and FlashBlade//S systems is three years; for FlashArray//E and FlashBlade//E systems it is six years. DFMs are replaced after 10 years for both FlashArray and FlashBlade systems. Replacement intervals for other components are based on expected service life.

- ▶ DFM data packs, or FlashBlade chassis, blades, and DFMs can be added to systems.
- ▶ DFMs can be exchanged for higher-capacity ones to consolidate capacity into a smaller data center “footprint” with lower power consumption.

On-demand upgrades differ from technology modernization in that they are done on subscriber request. Subscribers receive credit for any equipment returned to Pure Storage as part of an on-demand upgrade.

Evergreen//Forever subscriptions eliminate capital expenditures for hardware modernization for the lifetime of a system. When subscribers add or consolidate capacity (DFMs) or switch to higher performance controllers or blades they pay only for the difference between the original and upgraded equipment.

EVERGREEN//FLEX

Evergreen//Flex provides all Evergreen//Forever features to subscribers who purchase hardware at a substantial discount and pay periodic subscription fees based on the average capacity they use rather than the capacity purchased. Evergreen//Flex subscribers can size their hardware purchases to meet anticipated capacity needs but pay only for the average capacity they use during each billing period.

Evergreen//Flex subscribers can deploy purchased capacity on-premises, at co-location facilities, or in a public cloud (Azure or AWS at publication time) in the form of *Cloud Block Store™* (CBS) virtual FlashArrays. They can evacuate and move data packs of DFMs to other systems covered by the same subscription to redistribute capacity as needed.

Pure Storage bills Evergreen//Flex subscribers monthly, quarterly, or annually, at subscriber option, in amounts that reflect daily average capacity usage during the period, referred to as *Effective Used Capacity* (EUC).

Because Pure’s systems thin-provision volumes and file systems, EUC is not simply the sum of all provisioned volume and file system sizes. EUC increases only when clients first write data to a given volume or file system address or when they create new objects.

Systems calculate EUC at a granularity of one megabyte by tracking clients’ first writes to volume (LBA) and file ({inode,offset}) addresses. The first overwrite to a volume or file address after creation of a snapshot or clone increases EUC because original data is preserved and new data is written.⁸ Client TRIM, UNMAP, and delete object operations deallocate physical storage and may therefore reduce EUC. The definitive description of EUC calculation for Evergreen//Flex (and Evergreen//One) subscriptions is available at:

https://support.purestorage.com/Pure1/Pure1_Manage/006_Analytics/Effective_Used_Capacity_FAQ

⁸ Typically, only a small portion of a volume is overwritten after a snapshot is taken, so snapshot contributions to EUC are minor. An exception would occur with a volume that was encrypted after a snapshot was taken. Encryption changes all data in the volume, so the volume’s entire unencrypted content would be preserved in the snapshot. The encrypted content of the live volume would increase EUC.

APPENDIX: PURE STORAGE PRACTICES

Integral to the Pure Storage Modern Data Experience are several features that are uncommon or nonexistent elsewhere in the industry. These include:

RIGHT-SIZE GUARANTEE⁹

For a variety of well-understood I/O workloads and combinations of them, Pure Storage will, on customer request:

- ▶ Use Pure1 AI tools to estimate capacity and I/O performance needs and recommend configurations that meet a customer's stated requirements.
- ▶ Negotiate 12-month capacity *service level agreements* (SLAs).
- ▶ Augment system capacity at no cost to the customer if necessary to fulfill SLAs.

The Right-Size Guarantee eliminates the risk of mis-estimating needs prior to deploying storage. It is especially useful for new deployments where customers lack experience.

LOVE YOUR STORAGE (LYS) GUARANTEE

A customer's first acquisition of a Pure Storage system includes a no-questions-asked money-back guarantee. The customer can return a system within 30 days of receiving it for a full refund of product and subscription cost for any reason, provided that the system has been installed and connected to Pure1.

FLAT IS FAIR SUBSCRIPTION PRICING

With Flat is Fair subscription pricing, a system's base subscription rate doesn't increase for as long as its Evergreen subscription is active. Users can plan ongoing storage operating expenses far in advance. There are no "surprise" increases in subscription cost.

NO "ENDURANCE ANXIETY"

The lifetime replacement guarantee for flash devices eliminates user concerns about flash memory *endurance* (ability to retain data with repeated usage). Pure1™ data indicates that when managed by Purity software, average DFM lifetimes are well over 10 years. The devices regularly report status to Pure1, which schedules replacement well before the devices approach end-of-life.

FLEET-WIDE STORAGE MANAGEMENT

Pure Storage customers have access to Pure1 Manage, the company's cloud facility for system monitoring, AI-based capacity planning, and predictive analytics that detect potential issues before they occur and proactively initiate preventive measures.

With Pure1's *Pure Fusion* control plane, customers can consolidate and coordinate management of all their Pure Storage systems within a single interface. They can monitor system status, move workloads between FlashArrays, plan capacity needs with AI-based assistance, and manage their support cases, storage assets, and Evergreen subscriptions.

⁹ Applicable to FlashArray//X and FlashArray//XL systems at publication time.

ALL-INCLUSIVE SOFTWARE LICENSING

Pure Storage produces Purity software updates (which include DFM firmware updates) every one to three months. Updates include new features as well as reliability, efficiency, and performance improvements. Some examples illustrate the value of all-inclusive software licensing:

- ▶ 2017: Pure released ActiveCluster synchronous replication. At publication time, over a third of FlashArray systems on which the feature was in use had been acquired before the company introduced the capability.
- ▶ 2020: With the rollout of FlashArray File Services, FlashArray block servers with Evergreen subscriptions became eligible to serve files as well.
- ▶ 2022: When Pure Storage introduced SafeMode ransomware protection and recovery assistance, the feature was available immediately to all systems with Evergreen subscriptions at no incremental cost.

These and other capabilities automatically became usable on all deployed products with no downtime, performance degradation, or change in subscription fees.

“WHITE-GLOVE” SERVICE

Pure Storage regularly achieves the industry’s highest audited Net Promoter Scores¹⁰, due in no small part to the efficiency and quality of its after-the-sale service. Service is integrated with Pure1 alerting and analytics, which often identifies potential issues before they occur or before customers are aware of them and initiates support cases with Pure Storage Technical Services.

Technical Services also monitors impending environmental events (hurricanes, wildfires, etc.) to ensure that both customers and the support organization are as prepared as possible to avoid or minimize disaster-related outages.

The quality of Pure’s customer support is demonstrated by the fact that over 60% of support cases are initiated by the company, before customers are aware of impending issues. But when a customer *does* call, the call is answered by a support engineer, in most cases one familiar with the customer, not by an automated service.

¹⁰ A recognized measure of customer satisfaction with a vendor or service provider. Pure Storage’s independently audited scores are consistently in the mid-eighties.
See <https://www.netpromoter.com/know/>

REFERENCES

EVERGREEN PROGRAM DESCRIPTION

<https://www.purestorage.com/legal/evergreen-program-description.html>

EVERGREEN//FLEX FREQUENTLY ASKED QUESTIONS

<https://www.purestorage.com/docs.html?item=/type/pdf/subtype/doc/path/content/dam/pdf/en/wite-papers/faq-evergreen-flex.pdf>

EFFECTIVE USED CAPACITY (EUC) CALCULATION

https://support.purestorage.com/Pure1/Pure1_Manage/006_Analytics/Effective_Used_Capacity_FAQ

EVERGREEN//ONE STORAGE AS A SERVICE (STAAS) OVERVIEW

<https://www.purestorage.com/docs.html?item=/type/pdf/subtype/doc/path/content/dam/pdf/en/solution-briefs/sb-business-evergreen-one.pdf>

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